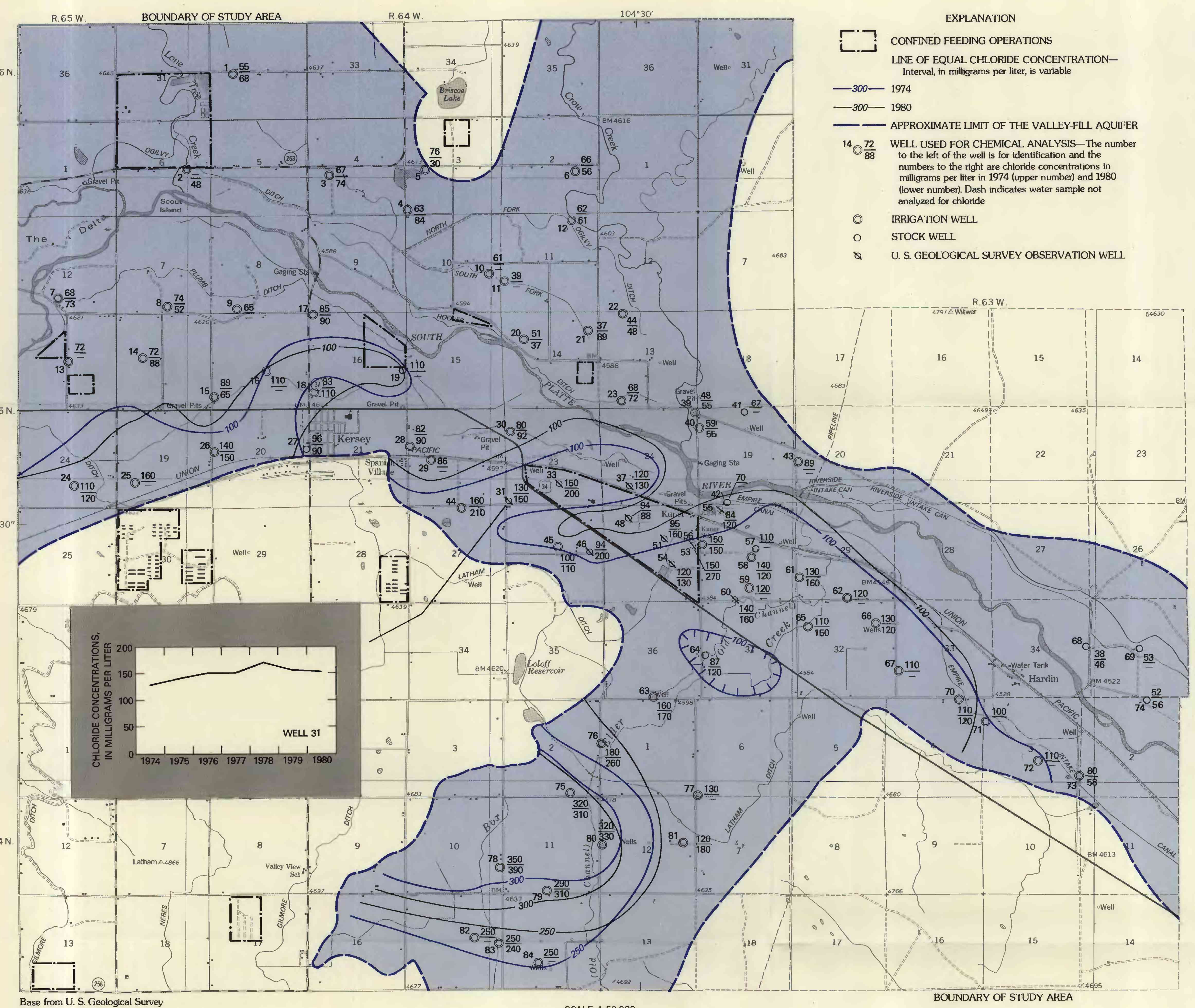

Figure 6. -- Chloride concentrations, 1974 and 1980.

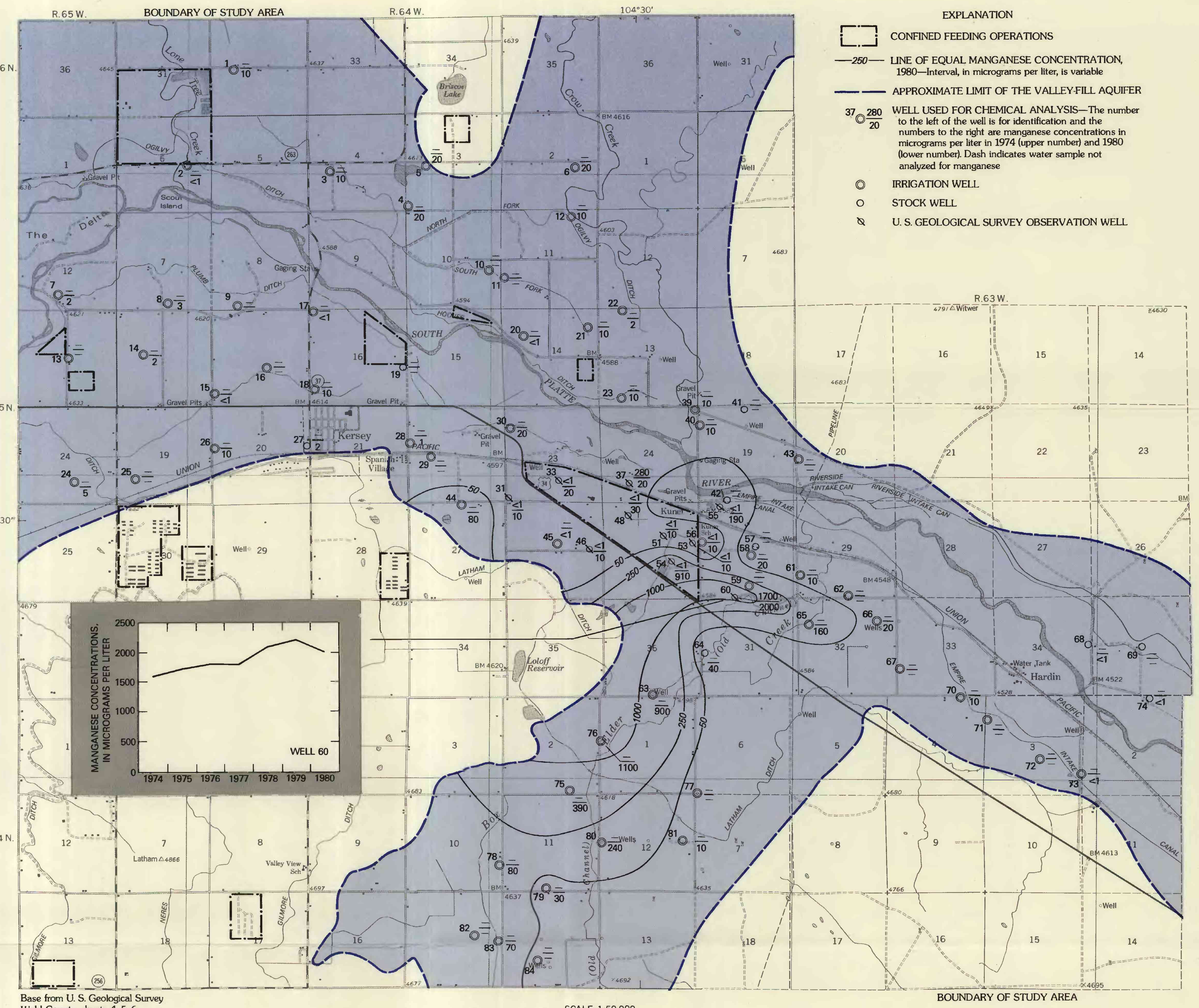

Figure 7. -- Manganese concentrations, 1974 and 1980.

Confined Feeding Operations

In 1980 there were 15 confined feeding operations--cattle feedlots and poultry farms--in the study area. The largest operation is a feedlot having a capacity of 90,000 head of cattle on the south bank of the South Platte River at the site of the former town of Kuner. The U.S. Geological Survey has been monitoring the quality of ground water in observation wells at and near this feedlot since 1974, before the feedlot was completed. The results of this monitoring indicate that the feedlot has had little effect on the ground-water quality (Borman, 1981, p. 1).

History of irrigation in the Greeley area

Agricultural development in the Greeley-Kersey area is comparatively recent. Before 1870, the study area was semiarid rangeland and had no irrigation wells, no regional irrigation canals, and almost no agriculture. Because the average annual precipitation at nearby Greeley is only 12.3 inches (Smith, 1964, p. 16), and because there were no irrigation canals to add recharge, the valley-fill deposits contained little water. Farming was restricted to the bottom lands of the Cache la Poudre and South Platte Rivers where short ditches could convey irrigation water from the nearby river (Brandhorst, 1977, p. 166).

During 1870, the Union Colony, led by Nathaniel Meeker, founded Greeley and began to build the first long-distance irrigation canals in Colorado. Irrigated croplands of the Colony extended throughout the northern part of the study area. Greeley Canal No. 2, the source of Brisco Lake, was constructed in 1870 to draw water from the Cache la Poudre River about 15 miles west of Greeley. Recharge to the valley-fill deposits increased greatly and added enough water to these deposits that wells drilled into them could be used for irrigation. Boyd (1897) describes a nearly dry well about 6 miles north of Greeley whose water level rose 50 feet after the nearby Larimer-Weld irrigation canal opened in 1880. Irrigation wells did not come into general use until the 1930's (Hurr and others, 1975, p. 5), although the first irrigation well in the Greeley area was dug by a Union Colonist in 1890 (Boyd, 1897). Large-capacity wells that yield more than 1,000 gallons per minute are now a major source of irrigation water in the study area.

GROUND-WATER QUALITY

Graphs of concentrations of selected constituents, in milligrams per liter, in the water from observation well 31 are plotted on the maps showing well locations and the concentrations of selected constituents. Concentrations of nitrite plus nitrate nitrogen are shown in figure 4, concentrations of sulfate are shown in figure 5, and concentrations of chloride are shown in figure 6. A similar graph of the concentration of manganese, in micrograms per liter, in the water from observation well 60 is shown in figure 7.

Nitrite plus Nitrate Nitrogen

Concentrations of more than 10 mg/L (milligrams per liter) of nitrite plus nitrate nitrogen are known to cause the blood disorder methemoglobinemia in infants less than 3 months old (U.S. Environmental Protection Agency, 1977a, p. 107-108). For this reason, the mandatory limit for public drinking water for nitrite nitrogen is 1 mg/L, and for nitrate nitrogen it is 10 mg/L. For irrigation water, however, nitrates are desirable as a fertilizer source, and large concentrations are not toxic to plants.

Much of the ground water in the study area contains nitrite plus nitrate nitrogen concentrations greater than the 10-mg/L drinking-water limit. Both the areal extent and concentrations increased from 1974 to 1980 (fig. 4). The median nitrite plus nitrate nitrogen concentration of 53 wells sampled during 1974 was 6.0 mg/L, the maximum was 16 mg/L, and the minimum was 0.9 mg/L. During 1980, the median concentration of the same 53 wells was 8.8 mg/L, the maximum was 32 mg/L, and the minimum was 0.6 mg/L. The nitrogen may be originating from agricultural fertilizers or from animal wastes from confined feeding operations. Other possible sources, such as municipal wastes or natural decay processes, are considered to be negligible.

Sulfate

Large sulfate concentrations in drinking water can affect its taste and act as a laxative (Peterson, 1951; 1972). The North Dakota State Department of Health found that the concentration of sulfate needed to cause a laxative effect varied with the person tested. In general, sulfate concentrations of more than 750 mg/L had a laxative effect and less than 600 mg/L had no laxative effect. The limit for sulfate in drinking water recommended by the U.S. Environmental Protection Agency (1977b, p. 17146) is 250 mg/L.

Sulfate concentrations exceeded 250 mg/L in all wells samples during 1974 and 1980, and concentrations of 1,000 mg/L were common. In the 53 wells sampled in 1974, the median concentration was 850 mg/L, the maximum was 2,100 mg/L, and the minimum was 330 mg/L. During 1980, the median concentration in the same 53 wells was 900 mg/L, the maximum was 1,700 mg/L, and the minimum was 360 mg/L. In general, sulfate concentrations increased slightly from 1974 to 1980.

The lines of equal concentration of sulfate indicate little areal increase, except for a small region at the center of the study area (fig. 5). Box Elder Creek Valley had the greatest sulfate concentrations in the study area, and an area downstream from Hardin had the smallest.

Chloride

Large chloride concentrations in drinking water can affect the taste and corrode plumbing fixtures. The limit recommended for drinking water is 250 mg/L (U.S. Environmental Protection Agency, 1977b, p. 17143-17147). This limit is based on taste rather than toxicity. No fixed limit has been set for agricultural use because the concentration that is harmful varies with the crop, climate, soil, and management practices (National Academy of Sciences, National Academy of Engineering, 1974, p. 329).

Chloride concentrations increased from 1974 to 1980. The median concentration during 1974 was 94 mg/L, the maximum was 350 mg/L, and the minimum was 37 mg/L. The median concentration during 1980 was 120 mg/L, the maximum was 390 mg/L, and the minimum was 30 mg/L. The largest increase was near Kuner where chloride concentrations increased more than 100 mg/L in two wells (fig. 6). Results from the 1974 and 1980 samplings indicate that the recommended limit of 250 mg/L for chloride was equaled or exceeded only in water from eight wells which were located in the Box Elder Creek Valley.

The distribution of chloride concentrations in the study area changed very little from 1974 to 1980. During 1974 all chloride concentrations more than 100 mg/L were south of the South Platte River. The greatest concentrations were in a small area in the Box Elder Creek Valley. The area in which concentrations exceeded 100 mg/L migrated to the South Platte River in two locations near Kuner and increased somewhat near well 64 from 1974 to 1980 (fig. 6).

Manganese

Manganese, one of the most common elements, is widely distributed in rocks and soils (Hem, 1970, p. 126). Large concentrations in water supplies can: stain plumbing fixtures, spot laundered clothes, accumulate deposits in distribution systems, and taste bad (U.S. Environmental Protection Agency, 1977a, p. 95-97). The limit recommended by the U.S. Environmental Protection Agency (1977b, p. 17144) for public water supplies based on user preference is 50 μg/L (micrograms per liter). For agricultural use, the U.S. Environmental Protection Agency (1977a, p. 96) recommends 10,000 μg/L on neutral and alkaline fine-textured soils (20-year use limit) and 200 μg/L on all other soils.

The lines of equal concentration in figure 7 indicate that manganese concentrations were greater than 50 μg/L in most of the Box Elder Creek area in 1980. Concentrations of about 1,000 μg/L were present in the same area, near two reservoirs and a swampy area about 1 mile northwest of well 63. It is possible that these reservoirs and swampy area are sources of the large concentration. According to Ingols and Wilroy (1963), manganese can be freed from the oxides in the soil under a reservoir by the reduction of organic material.

During 1974, the waters from 11 wells in and near the feedlot at Kuner were collected and analyzed for manganese. Of these, only the waters from wells 37 (280 μg/L) and 60 (1,700 μg/L) contained manganese in any detectable quantity (fig. 7). During 1980, samples were collected from 53 wells, and the waters from 11 of these had manganese concentrations greater than 50 μg/L. The median concentration in 1980 was 10 μg/L, the maximum 2,000 μg/L, and the minimum less than 1 μg/L.

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METRIC CONVERSION FACTORS

The inch-pound units used in this report may be converted to SI (International System of Units) by use of the following conversion factors:

Multiply inch-pound units	*By*	*To obtain SI units*
inch	2.540	centimeter
foot	0.3048	meter
mile	1.609	kilometer
foot squared per day	0.09290	meter squared per day
gallon per minute	0.06308	cubic meter per second
foot per year	0.3048	meter per year

National Geodetic Vertical Datum of 1929: A geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, and formerly called mean sea level.

NITROGEN, SULFATE, CHLORIDE, AND MANGANESE IN GROUND WATER IN THE ALLUVIAL DEPOSITS OF THE SOUTH PLATTE RIVER VALLEY NEAR GREELEY, WELD COUNTY, COLORADO

By
Neville G. Gaggiani
1984